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(54) REVERSED CONNECTING ROD MACHINE

[diagram]

(57) The invention consists of an apparatus for reducing loss in piston machines so as to obtain better output.

It consists of an extension arm (1) of piston (11) which slides in a frame (6) having an opening (16) in which the sliding is facilitated with bearings (15) that minimize friction with the extension arm (1). The reversed connecting rods (4) activate the extension arm (1) with the axle (3) and are maneuvered by two synchronized pins (9) from the crankshaft (10). When the engine is activated by the functioning of its pistons (11) in opposition, the association of the extension arms (1) replaces the frame (6) by a fitted slot (13) linking the extension arms (1).

According to the invention, the apparatus is specifically destined to improve internal combustion engine performance as well as improving the performance of compressors and piston machines.

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This invention pertains to an apparatus allowing for a direction reversal of connecting rods in the functioning of crankshaft piston machines, notably in internal combustion engines, as well as in piston compressors.

Internal combustion engines, including piston compressors, function in opposition to the principle of linear movement amplitude, transformed into a circular movement and inversely, given the applied stress, this movements transformation corresponds to a piston stroke that is asymmetrical with a shortened connecting rod from which we do not fully benefit. As with patent number 2674285, which puts forth the principle of type four levers but only with the implementation of a supplemental mobile piece, the German patent DE-A-33 27 225.5 accounts for the vibration phenomenon with these supplemental mobile pieces, but does not consider the importance of the connecting rod length which is determined in the non-symmetrical progression between the linear stroke of the pistons and the circular stroke of the crankshaft pin axle.

According to the invention, the apparatus enables us to solve these inconveniences by allowing the piston to have a linear movement while the crankshaft has a circular movement. These two pieces are linked by the connecting rod enabling a conversion movement, first towards one then towards the other, accompanied by applied forces that are and consist of:

- the equal distribution of kinetic energy from the flywheel given the increasing resistance in the compression time.
- the economizing of pressure after engine stroke combustion so as to allow for better use of the principle of parallelogram of forces, with a higher pressure.
- prolonging the time close to the upper neutral gear.
- burning all gases, reducing pollution and benefiting longer from the anticipation of ignition.
- allowing for an easier entry of combustible gases into the combustion chamber by reducing initial resistance.

- allowing for complete and less gas-resistant exhaust, while limiting or further benefiting from the delay in the closing of the valve.
- allowing for motor rotation with a slower speed during slow-down time.
- demonstrating, by mathematical formula, that with connecting rods of an increasingly shorter length, we obtain curves with increasingly pronounced outlines of asymmetry between the stroke towards the piston's upper neutral gear and the stroke towards the lower neutral gear.

This occurs according to a first distinction: on the one hand the connecting rod is simple and reversed once it is linked to the common articulation axle with two extension arms that surround the reversed connecting rod in order to rejoin the piston; and on the other hand, the crank arm is double-parallel and reversed when it is linked to the common articulation axle by one extension arm that passes between the two reversed connecting rods to rejoin the piston. The length "L" between both axles of the simple or double connecting rod determines the required amplification of the movement. It is determined starting from diameter "D" that is covered by the crankshaft pin axle.

According to the particular modes of implementation:

- the piston's two extension arms appear and become separated starting from the piston's first extension.
- the extension arm or the two extension arms are extended by a guide according to the articulation axle in order to slide into an opening fitted within a frame which will be inserted and fixed between the engine block and the oil crankcase.
- the frame consists of one single mechanical piece as part of the oil crankcase.
- the frame opening is equipped with bearings.

- the two extension arms, or the one extension arm, are independent of each other and are attached to the piston with a mechanical assembly.
- the extension is activated with a linear movement alternating between the two reversed connecting rods. These rods are activated by the circular movement of two mechanically synchronized pins secured by the two crankshaft handles.
- the extension arms of the first piston are linked to their common reversed connecting rod with the axle after the double apparatus allows for the sliding movement and connects the second piston's extension arms to the first piston's extension arms. The two reversed connecting rods are hinged to the common pin. The two connecting rods are set up opposite one another as is done in flat engines in which the cylinders set up on both sides of the crankshaft.
- the extension arm of the first piston connects to the axle by passing between its two common reversed connecting rods after the apparatus allows for the sliding movement and connects the extension arm of the second piston to the extension arm of the first piston. The four reversed connecting rods move in a two-by-two arrangement opposite one another on two mechanically synchronized pins. This begins with the two crankshaft rods so as to allow for the movement of a flat motor in which the cylinders are on each side of the crankshaft axle.
- the extension arms each have slots through which slides the axle common to the two reversed connecting rods and to the opposite piston extension.
- connecting rod length "L" is defined in a comparative manner according to a mathematical formula that determines the optimal asymmetrical piston stroke required.

$$OA = R \cdot \sin \alpha + \sqrt{L^2 - R^2 \cdot \cos^2 \alpha}$$

The drawings and charts in the annex illustrate the invention:

Figure 1 represents a circle separated into 24 sectors. These correspond to 13 vertical positions of alternating piston movements. These 13 positions allow the piston to progress differently towards the top and towards the bottom and vice versa, depending if we are looking at the sheet right side up or at a half-turn. To help in this comparison, we must replace letters with numbers based on the chart in folio 8. With this we may understand the reason and the way in which we are required to reverse the connecting rod.

Figure 2A represents the curves of the piston stroke. It is based on the two movements in figure 1, with a direct connecting rod and a reversed connecting rod, with one crankshaft rotation separated into 24 sectors starting from the lower neutral gear (LNG) passing through the upper neutral gear (UNG) and returning to the lower neutral gear (LNG).

Figure 2B allows us to proceed to a mathematical verification. By varying the length of the connecting rod we can apply the mathematical formula that will allow us to compare several asymmetrical curves and choose the connecting rod length which will achieve the best piston stroke. Folio 7 represents by indicative and approximate title the multiplication coefficients of dead volume which is at one at the upper neutral gear (UNG) of different types of engines, with a compression rate that can vary from 7 to 24 and accounting for the two piston displacements in figure 1. Not including the first position of the upper neutral gear (UNG), the chart is beginning from the second position of the pistons. It continues to the thirteenth position in order to compare the coefficients resulting from the different progressions of piston B having a reversed connecting rod; with decreasing coefficients resulting from different progressions from piston A having a direct connecting rod.

Knowing that this coefficient is a dead volume multiplicator and that it is within this that combustion is produced; this coefficient is also a divisor of the pressure obtained after the combustion. It is in this manner that we can explain the weak output of current engines and thereby improve.

Folio 8 represents two charts, as does folio 7, except that it converts the differences between the two coefficients into percentages. These are in favor of the reversed connecting rod. Both tables use letters A to M and M to A with numbered correlations.

Plate 3/6 with figure 2B explains the mathematical formula.

Figures 3, 4 and 5 represent different positions of the reversed connecting rod with different piston extensions linked to the connecting rod and pass through the frame.

Figure 6 represents a position in a flat motor having the piston extension arms passing outside of the movable reversed connecting rod crankshaft assembly.

Figure 7 represents a crankshaft in two parts. Each is equipped with a pin and a reversed parallel connecting rod. These are joined by an axle which guides the piston into a straight and direct extension. This extension goes up to the frame which is equipped with bearings that allow for the pieces to slide against each other with minimal friction.

Figure 8 represents the position of flat engines. There are four reversed connecting rods joined in pairs to the pins of a crankshaft in two parts. This replaces the function of a frame which significantly increases all measurements. With the implementation of forms adapted to piston extensions, we obtain a sliding piece between the two extensions and a consistent link in the functioning of the alternating linear axle between the two pistons.

Figure 9 represents a view of the piston assembly, the extension arms with their connections and their extensions passing through an opening within the frame. It also gives a representation of the reversed connecting rod arrangement and a manner by which to move it with the joining axle of the extension arms.

Referring to the drawings, the apparatus consists of extension 1 of piston 11. Extension 1 may be at the beginning of a separation by two extension arms 2 with the possibility of a screwed assembly 12. The separation allows for the stroke of a reversed connecting rod 4. The separation of the extension arms ends and connects, at articulation point 3, to the reversed connecting rod 4. Connecting rod 4 is brought into movement by pin 9 which in turn is activated by crankshaft 10. After joining articulation axle 3, extension 5 continues to pass through frame 6 through opening 16 equipped with bearings 15. The role of frame 6 is to maintain the guide that is extension 5. Frame 6 is to be inserted between engine block 7 and oil crankcase 8. Frame 6 may be omitted and replaced in the case of a flat engine where pistons 1 are placed on each side of crankshaft 10. This omission is possible on condition that extension arms 2 or extension arm 1 of the first piston 11 are connected in the sliding area 13 common to both extension arms 2 or extension 1 of the second piston 11. The possibility of joining reversed connecting rods 4 with extension 1 by axle 3 is accomplished with the placing of a slot 14 in extension 1 of the opposite piston 11.

According to a variation not illustrated, the synchronization and consolidation of the crankshaft's separate parts is obtained by placing an adjoining parallel axle. This is equipped with gears that join the different parts of the separated crankshaft or that can link several cranks.

According to a variation not illustrated, the frame is integrated with either the engine block or the oil crankcase.

For example, length "L" between both axles of the simple or double reversed connecting rod will be 0.8 times the diameter of the circle that is covered by the axle of the crankshaft pin.

The intent, according to the invention, is specifically aimed to obtain the best performance from internal combustion engines as well as with piston compressors by explaining the significance of a reversed piece and the importance determined by its length.

[Translator's Note: Please refer to page 7 of the French version. The only word on the page, TAUX, should  
be translated as RATIO]

[Translator's Note: Please refer to page 8 of the French version. The word, TAUX, should be translated as  
RATIO]

[Table:]

Piston Upper Neutral Gear (UNG)	Piston Upper Neutral Gear (UNG)
Piston Lower Neutral Gear (LNG)	Piston Lower Neutral Gear (LNG)

## CLAIMS

1/ Apparatus for piston machine which links the piston to a crankshaft with a connecting rod distinguished, on the one hand, by a connecting rod (4) that is simple and reversed when it is linked to the articulation axle (3) common to both extension arms (2) which surround the reversed connecting rod (4) to rejoin the piston (11); and on the other hand, by a connecting rod (4) that is double-parallel and reversed when it is linked to the articulation axle (3) common to the extension arm (1) that passes between both reversed connecting rods (4) to rejoin the piston (11). Length "L" between both axles of the simple or double connecting rod (4) regulates the speed of the required movement. The movement is determined based on diameter D that is the distance covered by the pin of axle (9) of the crankshaft (10).

2/ Apparatus according to claim 1 distinguished in that the two extension arms (2) of the piston (11) appear and separate beginning with the first extension (1) of the piston (11).

3/ Apparatus according to one or more of the preceding claims distinguished in that the extension arm (1) or the two extension arms (2) are extended by a guide (5) starting from the articulation axle (3) which passes and slides into an opening (16) fitted on to a frame (6) that is to be inserted and fixed between the engine block (7) and the oil crankcase (8).

4/ Apparatus according to one or more of the preceding claims distinguished in that the frame (6), as one single mechanical piece, constitutes one part of the oil crankcase (8).

5/ Apparatus according to one or more of the preceding claims distinguished in that the opening (16) of the frame (6) is equipped with bearings (15).

6/ Apparatus according to one or more of the preceding claims distinguished in that the two extension arms (2) or the extension arm (1) are separable and are assembled to the piston (11) with a mechanical assembly (12).

7/ Apparatus according to one or more of the preceding claims distinguished in that the extension (1) is activated in an alternating linear movement between the two reversed connecting rods (4), these being themselves activated by the circular movement of the two pins (9) mechanically synchronized starting from the two crankshaft handles (10).

8/ Apparatus according to claims 1, 2 and 6 distinguished in that the extension arms (2) of the first piston (11) rejoins the common reversed connecting rod (4) with the axle (3) after the double apparatus which enables sliding (13) and which connects the extension arms (2) of the second piston (11) with the extension arms (2) of the first piston (11). The two reversed connecting rods (4) activate the common pin (9). With an apparatus of two connecting rods (4) opposite one another for flat engines in which cylinders are placed on each side of the crankshaft axle.

9/ Apparatus according to claims 1, 6 and 7 distinguished in that the extension arm (1) of the first piston (11) connects to the axle (3) by passing between its two reversed common connecting rods (4) after the device that enables sliding (13) and that connects the extension arm (1) of the second piston (11) with the extension arm (1) of the first piston (11). The four reversed connecting rods (4) are activated with a two-by-two apparatus and opposite one another on two pins (9) mechanically synchronized starting from the two crankshaft handles (10) so as to accommodate a flat engine where the cylinders are placed on each side of the crankshaft axle.

10/ Apparatus according to the preceding claim distinguished in that the extension arms (1) each have a passage (14) in the shape of a slot into which slides the axle (3) common to both reversed connecting rods (4) and to the opposite piston (11) of extension arm (1).

11/ Apparatus according to one or more of the preceding claims distinguished in that the connecting rod length "L" corresponds to the optimal asymmetrical stroke required by the piston, namely:

$$OA = R \cdot \sin \alpha + \sqrt{L^2 - R^2 \cdot \cos^2 \alpha}$$

[Please refer to French version page 1/6]

HAUT = UP

BAS = DOWN

~~2 PISTON STROKES IN 24 SECTORS OF ONE CRANKSHAFT ROTATION~~

DIRECT CONNECTING ROD A

REVERSED CONNECTING ROD B

LNG

UNG

LNG

[Note: Please refer to the French version for graph and numbers]

FIG 2B

[drawing]

R = Circle radius based on the stroke of the crankshaft pin axle

L = Length of connecting rod

$\alpha$  = Rotation angle

$$OA = R \sin \alpha + \sqrt{L^2 - R^2 \cos^2 \alpha}$$

[Please refer to French version for page 4/6]

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[Please refer to French version for page 5/6]

[Please refer to French version for page 6/6]

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PRELIMINARY RESEARCH REPORT  
established on the basis of the latest claims  
available before beginning research

DOCUMENTS CONSIDERED RELEVANT

Category	Document quotation with indication, if necessary, of relevant sections	Pertinent claims of the request being reviewed
X	DE-C-802 485 (FLEMMING) April 12, 1951 *entire document*	1-4
X	US-A-1 769 375 (LEARY) July 1, 1930 *entire document*	1-4
X	FR-A-2 067 119 (GUILLON) August 20, 1971 *entire document*	1-3, 6, 7
X	DE-A-34 15 550 (SCHULZ) November 7, 1985	1-3, 6, 7

TECHNICAL FIELDS  
REQUIRED (Int. CL. 6)

F01B

F02B

Date [text illegible] of research

March 2, 1995

Examiner

Wassenaar, G.

CATEGORY OF DOCUMENTS QUOTED

X: particularly relevant in itself

Y: particularly relevant along with another document of the same category

A: relevant contrary to at least one claim or general technological background

O: non-written disclosure

P: inserted document

[letter illegible]: theory or principle based on the invention

E: patent document pertaining to a date previous to the copyright and that was published on the copyright date or on a later date.

D: quoted in the request

L: quoted for other reasons

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&: member of the same family, corresponding document